OCCURRENCE OF CRETACEOUS REPTILES IN THE MORENO SHALES OF THE SOUTHERN COAST RANGES, CALIFORNIA

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Communicated November 6, 1939

Recently, S. P. Welles called attention to a plesiosaur from the Upper Cretaceous of the San Joaquin Valley, California, and on the basis of its skeletal characters, long neck and short head, referred this sauropterygian to the family Elasmosauridae.[1] During the past summer, field parties from the California Institute of Technology explored the Moreno formation as exposed in the Panoche Hills, northwestern Fresno County. Our attention was drawn specifically to this region by the discovery of reptilian remains by Robert T. White of the Barnsdall Oil Company. The materials found by Mr. White proved to be on excavation a shoulder girdle, one flipper, a series of sixty or more vertebrae and remains of the posterior part of the skull and jaws of a plesiosaur. Apparently the marine reptile represented by these remains possesses several of the characters noted by Welles in the plesiosaur found approximately five miles farther north in the Panoche Hills, although the second specimen is distinctly smaller than the first.

Further search in the region where the second plesiosaur was found revealed the presence of two other types of reptiles. These represent mosasaurs and an hadrosaurian dinosaur. Both types are of interest, and the latter particularly, because for many years no record has been made of the presence of these groups in Cretaceous deposits of the Pacific Coast of North America, although they are not uncommon in certain horizons of the Cretaceous found elsewhere on the North American continent. Discovery of these reptiles in this far western area is of considerable scientific interest and possesses great significance since among other facts derived from the study of the remains as well as of the occurrence, light may be thrown not only on the age relationships of the Moreno but also upon the conditions under which at least certain portions of the formation accumulated.

The localities of occurrence of the fossil reptiles are found in the Panoche Hills, a region selected originally as the type locality for the two formations into which the Chico Cretaceous was divided by Anderson and Pack[2] in 1915. These authors recognized within the upper Cretaceous Chico Group, as exposed along the western border of the San Joaquin Valley north of Coalinga, California, a lower formation which they designated the Panoche and an upper formation called the Moreno. The two formations are ap-

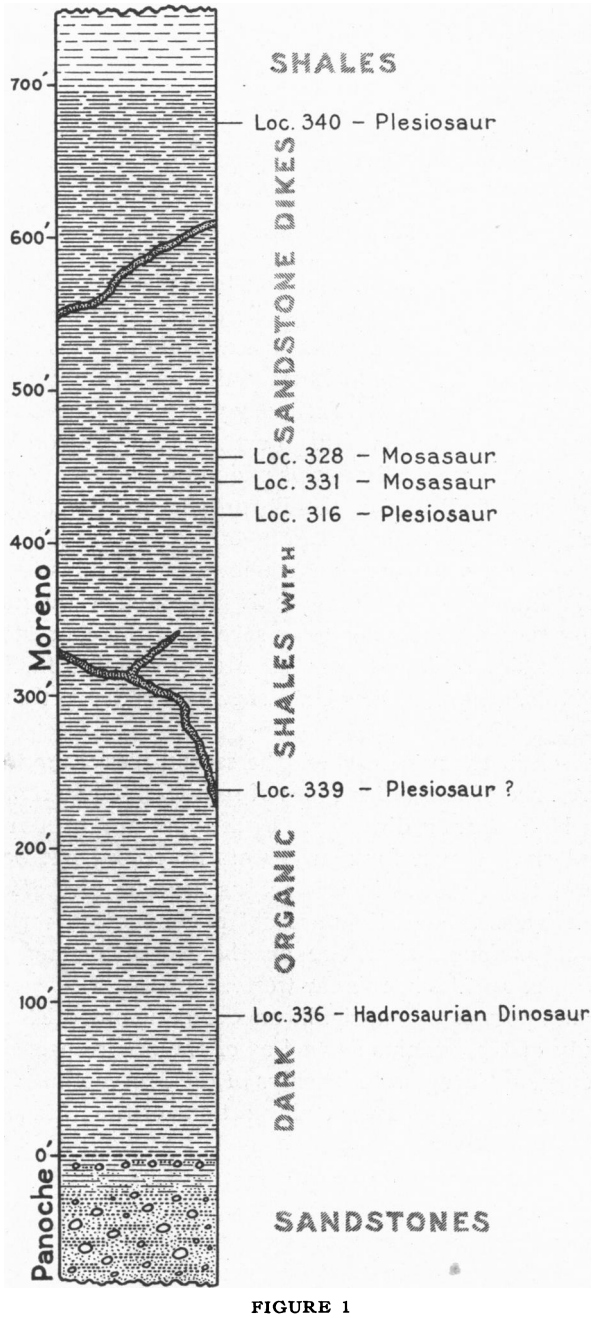

FIGURE 1

Columnar section showing contact of the Moreno and Panoche formations and lower portion of the Moreno with California Institute localities of occurrence of fossil reptiles in the Panoche Hills, northwestern Fresno County, California. Elevations indicated in feet.

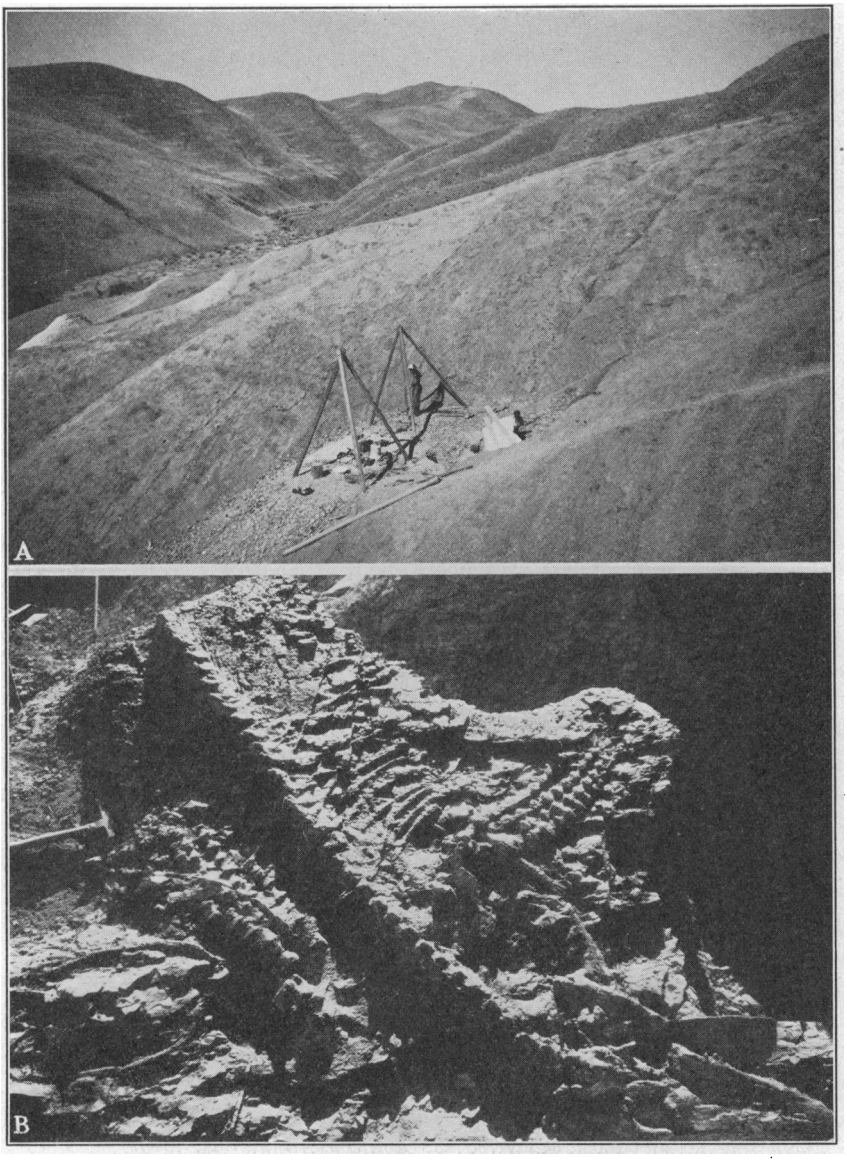

PLATE 1

Figure A. View looking west showing occurrence of mosasaur skull and skeleton at C. I. T. Vert. Pale. Loc. 331 in Cretaceous Moreno formation, Panoche Hills, northwestern Fresno County, California.

Figure B. Block containing mosasaur skull and skeleton excavated at locality 331. Note skull (lower right) and large flippers. At upper end of block and to right of vertebral column may be seen the organic material representing remains of food from the digestive tract of this marine reptile.

parently conformable. The line of separation between the Moreno and the Panoche has been taken where a rather well defined change in relief occurs from the steep slopes of the Panoche sandstones to the gentler and rounded topography of the Moreno shale. In most places it is expressed also by a distinctive difference in lithology, the sandstones of the Panoche giving way to the black shales of the Moreno. However, at the line of separation the change in deposits is not abrupt but is one of transition, for the upper standstone members in the Panoche formation are interbedded with shales like those which occur higher in the more typical parts of the Moreno. The shales are cut by sandstone dikes, as noted by Anderson and Pack, and at least in one instance a clastic dike of this type cut across a series of vertebrae of one of the marine reptiles entombed in the deposits. Not far above the highest fossil reptile occurrence, namely, at approximately 700 feet above the base, the characteristic dark shales of the Moreno are replaced by lighter colored shales.

As shown in the columnar section, figure 1, all the reptile localities thus far uncovered in the Panoche Hills by the California Institute occur in the Moreno formation. Their presence appears to be restricted to the lower 700 feet of the Moreno and fossil remains are found at various levels throughout this thickness. The specimen of an hadrosaurian dinosaur occurred approximately 100 feet above the base of the Moreno. Remains of plesiosaurs and mosasaurs were found higher in the section. Skull and skeletal parts are encrusted with gypsum and the specimens are usually rather well preserved. Apparently complete skeletons are rare, but parts of skeletons and skulls are not uncommon. In one instance, what appear to be gastroliths were found in association with plesiosaur remains. Another individual, in this instance a mosasaur, consists of a considerable portion of a skeleton with the skull (plate 1) found at locality 331. In this specimen organic material including fish remains and representing apparently food from the digestive tract of this marine reptile lay beneath the presacral portion of the vertebral column. Elsewhere in the reptile-bearing shales of the Moreno occur specimens of fossil wood, and fish remains as well as fossil invertebrates are found occasionally.

[1] Welles, S. P., Abstract, August, 1939, meeting of the Paleontological Society, Berkeley, California.

[2] Anderson, R., and Pack, R. W., *U. S. Geol. Surv. Bull.*, **603**, 46–57, pl. 5 (1915).